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Grain Unit Trains

Estimated Potential Cost Savings on a System Basis

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Canada

GRAIN UNIT TRAINS

ESTIMATED POTENTIAL COST SAVINGS ON A SYSTEM BASIS

by

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Canadian Transport Commission

1986

Canadian Transport Commission
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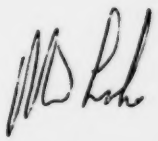
FOREWORD

The Research Branch of the CTC maintains a work program on the handling and transportation of Prairie grain. This program essentially involves the analysis of the grain marketing system by its major transportation and handling sub-components -- a) rail transport, b) truck transport, c) elevator handling, and d) vessel transport -- with a view to understanding the cost structures of each and how they are inter-related. The ultimate goal of this program is to integrate these components into a system model which would permit the evaluation of alternative grain transport scenarios.

The present paper is a "pilot study" comparison of the relative cost of conventional and unit train services. Some aspects are not included; others are treated most conservatively. However, the depth of the study is sufficient to illustrate significant potential for net savings and to indicate a clear direction for continued more detailed examination.

This working paper is being made available as part of the continuing program of communication of Research Branch projects. Comments will be welcomed by me, by Andrew Gemmell A/Director Freight Studies, and by the author, Joseph Kruger, A/Chief, Bulk Freight Division (819-997-6541).

Of course, the opinions expressed herein are those of the author and do not necessarily reflect the views of the Canadian Transport Commission.



R.W. Lake
Executive Director
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2. REPORT SUMMARY

This report has attempted to quantify on a broad basis an order of magnitude of railway variable cost savings which could arise from the development of a unit train system for the transportation of grain to major destinations in Canada.

Conservatively speaking, an average of about $58.0 million in railway variable cost savings per year for CP and CN combined could be realized. Estimated savings would be significantly higher if additional costs comprising line related costs, equipment costs and the effect of inflation in these costs over the long term were included. Reduction in these other costs should be included but they could not be determined with precision in the context of this report. Instead, a conservative scenario was developed assuming that 10% of all costs would be saved. The result was an estimated annual saving of $55 million. Based on these savings one would expect that a $500 million expenditure on the grain transport system would be repaid in about 20 years, assuming a 10% rate of discount.

The conclusion that can be drawn is that potentially significant cost savings can be realized in the transportation of grain, with system improvements. Based on this it would seem worthwhile and indeed appropriate to identify more specifically candidate origins for unit trains of grain, and using that information establish potential cost savings on a more detailed basis.

A point to point analysis would also be expected to compare rail cost savings with any additional costs created by potentially longer trucking distances for farmers, and any additional facility investments required. The overall net benefits accruing to the grain handling and transport system from a unit train operation could then be quantified. (Such a study is presently in progress with completion expected in the Spring of 1986.)

3. INTRODUCTION

The purpose of this report is to assess the cost savings if any (in terms of order of magnitude) which could be realized if the rail component of the existing grain handling and transportation system was made more efficient through introduction of unit train services.

The costs of moving grain for the year 1980 (1980 was chosen for convenience and data availability) were estimated using a simple algorithm (Appendix 1) and costs were then compared under two types of service environments:

(a) conventional train services based on a profile of rail services actually provided in 1980, and

(b) unit train services based on a hypothetical profile of potentially feasible services.

The report describes the methodology employed, and defines conventional train services and costs associated with them. The unit train analysis following describes a set of alternative operating models designed to handle 1980 grain shipments as though the grain handling and transportation system were operated according to unit train principles, and the associated costs. Variable costs for the two services are compared and savings are estimated.

The estimated savings are shown separately for CP Rail and CN Rail, followed by a sensitivity analysis.

The report includes an assessment of the present value of estimated cost savings. This value provides an initial estimate of the potential incentive available to stimulate a change in the transportation of grain.

4. METHODOLOGY

The approach chosen to estimate potential savings is based on the use of average train profiles as determined from system grain flows to major Canadian port destinations. These profiles are as specific as possible in the circumstances, identifying separately the movements to individual destinations via the respective railway companies.

Taking these average train profiles, estimated output units and Railway Transport Committee (RTC) approved railway variable costs were combined using a costing algorithm and a microcomputer. The results enabled a comparison of the costs of alternative services considered and provided estimated savings. These estimates were then reviewed with various interested parties including the railways, and appropriate adjustments were made.

It is acknowledged that it would be most desirable to develop train profiles for individual origins and destinations. However, when this study was first undertaken, such an identification of sources or specific origins for unit trains, did not exist. Unfortunately, the establishment of these points (really the basis of a rationalized system), was not feasible within the time frame of this project, and the limited availability of resources and data. This does not imply that it cannot or should not be done, but rather that, for the purpose of this analysis, which was to provide a broad perspective on the potential savings in rail costs arising from a more efficient operation, the loss of specificity was not considered serious. In

any event, it was the intention to proceed with development of more detail should potentially significant savings be indicated in this study.

5. CONVENTIONAL TRAIN COST ANALYSIS

This section of the report assesses the cost of moving export grain from Prairie origins to the various major destinations of each railway assuming that service is conventional. That is, the composition of rail services from the time the grain car is loaded until delivery at a particular port destination, is assumed to include switching at origins, destinations and likely intermediate points as well. Traffic is assumed to be shipped in carload (or multiple carload) lots using on average the type of operation or rail service actually provided in 1980.

The most widely publicized and quoted source of information on railway costs in grain service is probably the report of the Snavely Commission. It provided an important data base for the study. From this information estimated output units for conventional services were developed and costed using 1980 railway unit costs as approved by the Railway Transport Committee.

By constructing a model of conventional train operations and costing it, comparisons with potential unit train services were possible and estimates of cost savings were quantified.

CN Conventional Train Cost Models

Operating models were calibrated separately for CP and CN so as to develop as specific an average train profile as possible for costing purposes. These are described below.

CN Rail

Using the year 1980 as the base year of the analysis total export grain traffic by major destination, i.e., Thunder Bay, Vancouver and Prince Rupert were developed as shown in Table 1.

Table 1

CN EXPORT GRAIN* TRAFFIC (1980)

Destination	Total Carloads	Total Tons
Thunder Bay	114,343	7,760,706
Vancouver	60,360	4,234,719
Prince Rupert	23,351	1,520,140
TOTAL	198,054	13,515,565

*Includes direct shipment non-reciprocal grain; about 98% of total.

In the same year these carloadings were shipped in trains averaging 82 cars and 4,900 tons over all. More specifically train profiles to each of the major points were as follows.

Table 2

CN TRAIN PROFILES** FOR EXPORT GRAIN* (1980)

ITEM	DESTINATION		
	THUNDER BAY	VANCOUVER	PRINCE RUPERT
Average Cars/Train	86	81	77
" Tons/Load	67.9	70.2	65.1
" Loaded Miles/Car	861	954	1375
" Empty Return %	97	95	85
" Car Days/Load	17.9	18.5	22.7
" Yard Switching Minutes/Car	41.2	38.1	33.1
" Locomotives/Train	2.72	2.37	2.55
" Tons/Train	2955	2913	2523
" Train Switching Minutes/Train	175.5	142.3	162.4

*Includes direct shipment non-reciprocal grain; about 98% of total

**Source: 1980 Costs and Revenues Incurred by The Railways in The Transportation of Grain Under Statutory Rates, Snavely, King and Associates, January 1982.

Under 1980 operating conditions the following output units or work units were estimated.

Table 3

CN OUTPUT UNITS FOR EXPORT GRAIN (1980)

ITEM	DESTINATION		
	THUNDER BAY	VANCOUVER	PRINCE RUPERT
Net Tons	7,760,706	4,234,719	1,520,140
Car Days	2,048,068	1,115,342	530,127
Car Miles (Loaded + Empty)	193,823,675	112,240,190	59,444,982
(Loaded)	98,387,652	57,559,072	32,116,206
Gross Ton-Miles (000's)	11,438,328	6,749,263	3,495,425
Net Ton-Miles (000's)	6,696,462	4,033,424	2,087,049
Yard Switching Minutes	4,709,784	2,298,768	773,680
Train Switching Minutes	461,000	206,860	91,400
Crew Wages ($)	8,050,607	4,873,022	2,761,056
Train Miles	2,266,165	1,384,860	772,811
Diesel Miles	6,156,682	3,287,356	1,967,962
Fuel (gals.)	16,391,071	9,671,271	5,008,406
Grain Door Loads	59,778	31,294	16,014

Source: 1980 Costs & Revenues Incurred by The Railways in The Transportation of Grain Under Statutory Rates, Snavely, King and Associates, January 1982.

CP RAIL

With the year 1980 as the base period the total export grain traffic by major destination, i.e., Thunder Bay and Vancouver were developed as shown in Table 4.

Table 4

CP EXPORT GRAIN* TRAFFIC (1980)

DESTINATION	TOTAL CARLOADS	TOTAL TONS
Thunder Bay	138,858	10,229,863
Vancouver	48,540	3,680,543
TOTAL	187,398	13,910,406

*Includes direct shipment non-reciprocal grain; about 98% of total.

This traffic was moved in trains of about 82 cars and 5,300 tons on average. Table 5 below contains more detail on train profiles to each major destination.

Table 5

CP TRAIN PROFILES** FOR EXPORT GRAIN* (1980)

ITEM		DESTINATION	
		THUNDER BAY	VANCOUVER
Average	Cars/Train	86	72
"	Tons/Load	73.7	75.8
"	Loaded Miles/Car	865	901
"	Empty Return %	88.0%	88.0%
"	Car Days/Load	17.8	23.1
"	Yard Switching Minutes/Car	26.9	36.9
"	Locomotives/Train	2.57	4.15
"	Tons/Train	3363	2903
"	Train Switching Minutes/Train	182.0	152.8

*Includes direct shipment non-reciprocal grain; about 98% of total.

**Source: 1980 Costs and Revenues Incurred by The Railways in The Transportation of Statutory Rates, Snavely, King and Associates, January 1982.

Under 1980 operations the following output units were estimated.

Table 6

CP OUTPUT UNITS FOR EXPORT GRAIN (1980)

ITEM	DESTINATION	
	THUNDER BAY	VANCOUVER
Net Tons	10,229,863	3,680,543
Car Days	2,471,620	1,123,143
Car Miles (Loaded + Empty)	225,684,427	81,946,719
(Loaded)	120,063,885	43,710,952
Gross Ton-Miles (000's)	14,565,329	5,423,301
Net Ton-Miles (000's)	8,811,421	3,295,771
Yard Switching Minutes	3,742,141	1,793,260
Train Switching Minutes	553,732	193,736
Crew Wages ($)	9,939,875	4,338,636
Train Miles	2,620,595	1,135,671
Train Hours	103,594	52,279
Diesel Miles	6,740,684	4,718,402
Fuel (Gals.)	18,673,123	8,742,982
Grain Door Loads	72,808	25,164

Source: 1980 Costs and Revenue Incurred by The Railways in The Transportation of Grain Under Statutory Rates, Snavely, King and Associates, January 1982.

Using the above estimated output units for conventional train services together with Railway Transport Committee (RTC) approved costs, the estimated variable costs of moving grain on the two railways in 1980 were calculated as follows. Costing was based on the use of the algorithm shown in Appendix 1.

Table 7

ESTIMATED CONVENTIONAL TRAIN VARIABLE COSTS (1980)

DESTINATION	CN VARIABLE COSTS $	CP VARIABLE COSTS $
Thunder Bay	98,144,832	112,827,885
Vancouver	55,190,947	51,433,638
Prince Rupert	28,180,189	-
TOTAL	181,515,969	164,261,524

These totals are not directly comparable to cost estimates provided in the report - 1980 Costs & Revenues Incurred by the Railways in The Transportation of Grain under Statutory Rates (Snavely Report). For one thing, the above costs do not include line related costs. Car day costs are also excluded on the assumption that a significant number, if not the entire covered hopper fleet in grain is owned by the Canadian Wheat Board and other public or private interests. It is further assumed that railway-owned boxcars presently used in grain service are close to being fully depreciated. Nevertheless, these excluded items are a potentially fertile source of cost savings, and more discussion on this is provided later in the report.

For simplicity, and perhaps without loss of generality, destinations such as Armstrong and Churchill have been excluded. Reciprocal grain is also excluded from the analysis accounting for roughly 2%-3% of the total traffic. Costs of capital have been estimated at the rate of 20.82% as approved by the RTC, compared with 25.4% before tax used in the Snavely Report.

Taking these exclusions into account, the costs in Table 7 compare reasonably with estimates in the Snavely Report (i.e. including line related costs) of $280 million for CN and $259 million for CP.

6. UNIT TRAIN COST ANALYSIS

Unit train services have been termed the "ideal" railway operation. Akin to a pipeline on wheels, the product is moved from origin to destination without intermediate switching or handling thereby minimizing railway costs and maximizing efficiency of service. One of the important impacts of a unit train operation is the reduction of turnaround time between origin and destination. Equipment utilization is improved, increasing capacity and reducing the need for acquisitions as traffic grows.

The application of unit train services in the handling of grain on a system basis is an ideal in itself at the present time. Many institutional and operational factors must be considered before it can be stated that the concept is feasible and economic. For example, a unit train demands a relatively high volume and continuous supply of product at the origin. This may require farmers to truck longer distances than at present. It may also precipitate the need for consolidation of delivery points and investment in storage, loading, and unloading facilities. At the present time there does not exist a representation of a logically rationalized delivery point network consequently the unit train savings for specific origin/destination pairs is difficult to estimate.

However, before moving on to the question of a detailed feasibility study, there must first be an overall appreciation of the benefits (i.e., cost savings) which can be generated by implementing the concept of unit trains. The following analysis attempts to provide this system perspective by comparing the variable costs of conventional vs unit train services. The

resulting figures so generated, provide an order of magnitude comparison and thereby an initial estimate of the potential for savings, as if all grain traffic (as defined herein) were transported in unit train services.

Unit Train Cost Models

Unit train operating models were constructed separately for CN and CP and a number of variations were introduced to test the cost sensitivity of the assumptions. It was recognized that numerous additional variations from these models were possible and so discussions were held with officials of both railways to obtain input on what would actually occur in practice. Following these consultations, the savings were recalculated. Tables 8 through 11 show the initial and adjusted models used for CN and Tables 12 through 15 show the initial and adjusted models for CP.

CN Rail

Table 8

CN UNIT TRAIN PROFILE FOR EXPORT GRAIN (1980)

ITEM		DESTINATION		
		THUNDER BAY	VANCOUVER	PRINCE RUPERT
Average	Cars/Train	100	100	100
"	Locomotives/ Train	3	3	4
"	Loaded Miles/Car	861	954	1375
"	Empty Return %	100.0	100.0	100.0
"	Car Days/Cycle	4.0	4.5	5.8
"	Yard Switching Minutes Car**	28.8	28.8	28.8
"	Tons/Load	85.0	85.0	85.0
"	Tons/Train	8500.0	8500.0	8500.0

*35 m.p.h. to Thunder Bay, 35 m.p.h. to Vancouver, 30 m.p.h. to Prince Rupert
**1 day switching time per trip per train provided for at origin and destination.

This basic model resulted in the output units as detailed below in Table 9.

Table 9

CN UNIT TRAIN OUTPUT UNITS FOR EXPORT GRAIN (1980)

ITEM	DESTINATION		
	THUNDER BAY	VANCOUVER	PRINCE RUPERT
Net Tons	7,760,706	4,234,719	1,520,140
Car Days	365,210	224,191	103,727
Car Miles			
(Loaded + Empty)	157,222,773	95,056,986	49,181,000
(Loaded)	78,611,387	47,528,493	24,590,500
Gross Ton-Miles			
(000's)	11,791,708	7,129,274	3,688,575
Net Ton-Miles			
(000's)	6,696,462	4,033,424	2,087,049
Yard Switching Minutes	3,293,078	1,738,368	672,509
Crew Wages ($)	6,167,634	4,227,240	2,760,043
Train miles	1,572,228	950,570	491,810
Diesel Miles	4,716,683	2,851,710	1,967,240
Fuel (Gals.)	12,557,330	8,389,616	5,006,568

The above unit train model if applied in grain services results in a total estimated variable cost in 1980 dollars of $144,180,425.

The following includes adjustments based on railway supplied information.

Table 10

CN UNIT TRAIN PROFILE FOR EXPORT GRAIN (1980)

(Adjusted)

ITEM		DESTINATION		
		THUNDER BAY	VANCOUVER	PRINCE RUPERT
Average	Cars/Train	98	98	98
"	Locomotives/Train	3	3	4
"	Loaded Miles/Car	861	954	1375
"	Empty Return %	100.0	100.0	100.0
"	Car Day Cycle*	8.0	8.5	9.8
"	Yard Switching Minutes/Car**	23.0	21.3	18.5
"	Tons/Load	93.0	93.0	93.0
"	Tons/Train	9114.0	9114.0	9114.0

*Based on railway estimates.
**Based on railway estimates for Thunder Bay.

These adjustments resulted in the output units as detailed below in Table 11.

Table 11

CN UNIT TRAIN OUTPUT UNITS FOR EXPORT GRAIN (1980)

(Adjusted)

ITEM	DESTINATION		
	THUNDER BAY	VANCOUVER	PRINCE RUPERT
Net Tons	7,760,706	4,234,719	1,520,140
Car Days	776,071	449,939	186,217
Car Miles			
(Loaded + Empty)	143,698,234	86,880,041	44,950,376
(Loaded)	71,849,117	43,440,021	22,475,188
Gross Ton-Miles (000's)	11,352,160	6,863,523	3,551,080
Net Ton-Miles (000's)	6,696,462	4,033,424	2,087,049
Yard Switching Minutes	2,629,889	1,285,668	431,994
Crew Wages ($)*	5,209,097	3,119,510	1,638,737
Train Miles	1,466,308	886,531	458,677
Diesel Miles	4,428,252	2,659,593	1,376,032
Fuel (Gals.)*	11,789,433	7,824,417	3,501,961

*These estimates are based on train-miles and gross ton-miles in proportion to conventional train outputs.

The adjusted unit train model if applied in grain services provides an estimated variable cost in 1980 dollars of $127,785,789.

CP Rail

The basic unit train model hypothesized for CP Rail is indicated below in Table 12, and the associated output units in Table 13.

Table 12

CP UNIT TRAIN PROFILE FOR EXPORT GRAIN (1980)

ITEM	DESTINATION	
	THUNDER BAY	VANCOUVER
Average Cars/Train	100	100
" Locomotives/Train	3	5
" Loaded Miles/Car	865.0	901.0
" Empty Return %	100.0	100.0
" Car Days Cycle*	4.00	4.25
" Yard Switching Minutes/Car**	28.8	28.8
" Tons/Load	85.0	85.0
" Tons/Train	8500.0	8500.0

*35 m.p.h. to Thunder Bay, 30 m.p.h. to Vancouver.
**1 day switching time per trip per train provided for at origin and destination.

Table 13

CP UNIT TRAIN OUTPUT UNITS FOR EXPORT GRAIN (1980)

ITEM	DESTINATION	
	THUNDER BAY	VANCOUVER
Net Tons	10,229,863	3,680,543
Car Days	481,405	173,202
Car Miles		
(Loaded + Empty)	208,207,800	78,027,512
(Loaded)	104,103,900	39,013,756
Gross Ton-Miles (000's)	15,615,585	5,852,063
Net Ton-Miles (000's)	8,811,421	3,295,771
Yard Switching Minutes	3,999,110	1,397,952
Crew Wages ($)	5,707,886	1,850,144
Train Miles	2,082,078	780,275
Diesel Miles	6,246,234	3,901,376
Fuel (Gals.)	17,303,392	7,229,070
Train Hours	59,488	22,294

In this context a unit train system in grain service results in total estimated variable costs of $143,196,401 in 1980 dollars.

Similarly, the adjusted model was developed as shown below.

Table 14

CP UNIT TRAIN PROFILE FOR EXPORT GRAIN (1980)
(Adjusted)

ITEM		DESTINATION	
		THUNDER BAY	VANCOUVER
Average	Cars/Train	125	100
"	Locomotives/Train	3	5
"	Loaded Miles/Car	865.0	901.0
"	Empty Return %	100.0	100.0
"	Car Day Cycle*	10.00	10.00
"	Yard Switching Minutes/Car**	15.0	20.6
"	Tons/Load	94.0	94.0
"	Tons/Train	11750	9400

*Based on railway estimates.
**Based on railway estimates for Thunder Bay.

After these adjustments the CP operating model generates output units as shown in Table 15.

Table 15

CP UNIT TRAIN OUTPUT UNITS FOR EXPORT GRAIN (1980)

(Adjusted)

ITEM	DESTINATION	
	THUNDER BAY	VANCOUVER
Net Tons	10,229,863	3,680,543
Car Days	1,088,283	391,547
Car Miles		
(Loaded + Empty)	188,273,010	70,556,792
(Loaded)	94,136,505	35,278,396
Gross Ton-Miles (000's)	14,967,704	5,609,265
Net Ton-Miles (000's)	8,811,421	3,295,771
Yard Switching Minutes	2,082,870	999,924
Crew Wages ($)*	5,712,932	2,695,501
Train Miles	1,506,184	705,568
Diesel Miles	4,518,552	3,527,840
Fuel (Gals.)*	19,188,978	9,042,777
Train Hours	43,034	20,159

*These estimates are based on train-miles and gross ton-miles in proportion to conventional train outputs.

This results in total estimated variable costs of $130,905,482 in 1980 dollars.

7. COMPARISON OF CONVENTIONAL AND UNIT TRAIN SERVICES

Combining the estimated CN and CP unit train variable costs with the estimated variable costs of conventional services produces the following comparison as shown in Table 16.

Table 16

COMPARISON OF UNIT TRAIN/CONVENTIONAL TRAIN 1980 VARIABLE COST
(Basic Model)

ITEM	DESTINATION		
	THUNDER BAY	VANCOUVER	PRINCE RUPERT
	$	$	$
CN Unit Train	73,803,147	45,224,894	25,152,384
Conventional Train	98,144,832	55,190,948	28,180,189
Estimated Savings	24,341,685	9,966,054	3,027,805
Total CN Potential Savings			37,335,544
CP Unit Train	101,363,373	41,833,028	-
Conventional Train	112,827,885	54,433,638	-
Estimated Savings	11,464,512	9,600,610	
Total CP Potential Savings			21,065,122
Grand Total Savings CP and CN			58,400,666

The contrasting estimate based on railway suggested modifications is shown in Table 17.

Table 17

COMPARISON OF UNIT TRAIN/CONVENTIONAL TRAIN 1980 VARIABLE COST

(Adjusted Model)

ITEM	DESTINATION		
	THUNDER BAY	VANCOUVER	PRINCE RUPERT
	$	$	$
CP Unit Train	67,539,136	40,452,028	19,794,625
Conventional Train	98,144,832	55,190,948	28,180,189
Estimated Savings	30,605,696	14,738,920	8,385,564
Total CN Potential Savings			53,730,180
CP Unit Train	89,483,280	41,422,202	-
Conventional Train	112,827,885	51,433,639	-
Estimated Savings	23,344,605	10,011,437	-
Total CP Potential Savings			33,356,042
Grand Total Savings CP and CN			87,086,222

Analysis of CP Rail Savings

With respect to Thunder Bay savings occur in virtually every cost component with major savings in crew wages, train miles, and train switching. In two instances costs actually increased, i.e., gross-ton-miles and yard switching. This can be accounted for by the fact that the unit train model assumes a 100% empty return movement whereas in 1980 the overall average empty return was about 89%. This difference increases the gross-ton-miles and switched cars chargeable to the unit train movement. However, in the basic model for Thunder Bay an additional factor is that average switching time per car is perhaps overly conservative being slightly higher than what

occurred in 1980. If adjusted to the actual average yard switching minutes in 1980, the reduced cost for unit train services would be about $250,000. This figure could also be considered conservative given switching times per car, provided in the "Adjusted" case. Similarly, estimated savings for movements to Vancouver followed the same pattern with the exception that yard switching cost savings were more pronounced.

Analysis of CN Rail Savings

As for CP, savings cover most cost components with major savings occurring in crew wages, train miles, diesel miles and fuel.

The slight increase in gross-ton-mile costs is similarly attributable to the higher empty return percentage assumed for the unit train operation as compared with the actual 1980 average empty return ratio.

8. SENSITIVITY ANALYSIS OF UNIT TRAIN COSTS (BASIC MODEL ONLY)

In order to weigh the effect of a change in the elements of the average train profile on estimated costs, a sensitivity analysis was done. Variations from the base case were considered using three key parameters in the unit train profile i.e.:

- the average content tons per car
- the number of cars per train
- the number of locomotives per train.

CP Rail

For CP Rail, a reduction of about 5.8% in the tons per car to 80 tons (slightly higher than the average tons/load in 1980) all other things held constant, increased total variable cost from the base case by roughly $6.4 million or 4.5%.

An increase in the number of cars (about 10%) per train (more closely matching the gross tonnage to the locomotive A-rating) all other things held constant produced a cost lower than the base case by about $5.8 million or 4%.

A reduction in the locomotive consist (really equivalent to an increase in the gross tons per locomotive hauled) produced a similar result to varying the number of cars per train. Therefore, within the context of these assumption CP Rail's savings in variable cost from a unit train

operation were estimated to be between roughly $14.7 million and $26.9 million.

CN Rail

CN Rail's variable cost increased from the base case by about $6.7 million or 4.6% when the content weight per load was reduced by 5.8% to 80 tons, all other things constant.

When the size of the train was increased by 10%, all other things equal, the base case variable cost was reduced by $7.6 million or 5.3%.

Similarly, a reduction in the locomotive consist (or equivalently an increase in the tons per locomotive hauled) produced comparable results to the adjustment of the number of cars per train.

Therefore, CN Rail's savings in this context were estimated to range between $30.6 million and $44.9 million.

Combining both CP and CN, estimated variable cost savings would range from $45.3 million to $71.8 million, and the simple average of the two is $58.5 million.

Considered on a percentage basis, one could conclude from this (all things being equal) that introduction of a unit train service for grain would result in variable cost savings of 12.7% for CP and 20.8% for CN or 16.9% overall. One could also conclude that some items (such as content tons) are

relatively cost sensitive to changes in assumptions and for a more detailed origin/destination analysis these operating parameters should be more accurately specified.

9. OTHER FACTORS INFLUENCING THE ANALYSIS

As noted earlier, the purpose of this document is to estimate the potential for savings arising from a unit train type of service for movement of grain. Naturally, given the global nature of the cost analysis, one must attempt to be as conservative as possible. That is why the initial focus was restricted to variable costs only. The intention was to show that if a reasonable amount of cost savings could be demonstrated in this way, then it would be worthwhile to investigate savings more specifically for grain movements from and to particular points.

Other costs not considered in the foregoing but which may ultimately have an impact, are rail savings arising from such items as line related costs. Since the nature of a unit train operation requires sufficient volume at the origin, it is expected that consolidation of delivery points would be required. Farmers would truck their grain longer distances to these alternate points or to higher throughput elevator locations. This would eventually lead to savings in line related costs. The proportion of savings in line related costs alone (about $100 million for CN and CP in total) may offset any additional costs of shipping by truck thereby permitting appropriate incentives to be offered.

Another cost element not specifically considered but relevant on a system basis, is capital cost savings with respect to equipment, i.e., rail cars and locomotives. Certainly, with a unit train system in operation, locomotives and railcars are cycled faster and therefore overall equipment requirements are proportionately reduced. This should result in significant

cost savings to the railways (in the case of locomotives) and the Federal Government (in the case of rail cars). For example, with the improved cycle times and higher car loadings previously outlined, additional capacity could be provided to handle an increase in grain traffic of approximately 60%. This implies the deferral of substantial capital expenditures for cars when traffic is growing. In 1980 terms this means that at least the $91 million spent by the Federal Government on hopper cars would have been saved. Overall, the additional capacity provided (8 000 cars) would have an estimated capital value of roughly $360 million.

Cost escalation would also influence the amount of savings potential. As escalation occurs one would normally expect it to have a greater impact on conventional train operations (because they are less efficient and costlier) than on unit train operations. The higher the rate of inflation in these costs the greater the savings flowing from the implementation of a more efficient system. In other words, inflationary increases in capital expenditures required to meet traffic growth would also be reduced or deferred eliminating the need to pass on these costs through the grain freight rate.

Were estimated savings determined on a more specific basis to include reduction in line related costs, deferred capital costs and the effects of inflation, then annual savings and the present value of future cash flows would likely increase significantly.

One additional aspect which affects estimated savings is the proportion of traffic already moved by unit trains (or their equivalent).

This obviously has a direct effect on savings, but it was not possible to break out this figure specifically. Instead a 10% solution was devised. This estimate, of savings, shown below was considered conservative enough to account for any potential error. That is, savings would probably exceed this amount, but not likely be less.

To illustrate the point using the "adjusted model", with no cost escalation, assume the following:

- 10% of line related costs are saved; $10 million
- 10% of estimated car day costs are saved; $36 million
- 10% of estimated operating costs savings $9 million,

This 10% case results, in total annual savings of $55 million, with a present value of roughly $470 million over 20 years at a 10% discount rate.

10. SUMMARY AND CONCLUSIONS

This report has attempted to quantify on a broad basis an order of magnitude of railway variable cost savings which could arise from the development of a unit train system for the transportation of grain to major destinations in Canada.

Conservatively speaking, an annual saving of about $58.0 million in railway variable costs for CP and CN combined would be realized. This level of estimated annual savings taken over a twenty year period at a 10% rate of discount would have a present value of about $500 million. Estimated savings would be significantly higher if line related costs, equipment costs and the cost escalations over the long term were included. It was recognized at the outset that these other costs are important but they could not be determined with precision in the context of this report. If these costs are included, even based on the 10% case presented herein annual savings are still $55 million.

This leads to the conclusion that potentially significant cost savings can be realized in the transportation of grain, with system improvements. Based on this it would seem worthwhile and indeed appropriate to identify more specifically candidate origins for unit trains of grain, and using that information establish potential cost savings on a more detailed basis.

A point to point analysis would also be expected to compare rail cost savings with additional costs created by potentially longer trucking

distances for farmers, and any additional facility investments required. The overall net benefits accruing to the grain handling and transport system from a unit train operation could then be quantified.

Appendix I

TRAIN COSTING ALGORITHM

$$\text{Total Variable Cost} = \left(\frac{Bj \div c}{xy}\right)\left((2\,Mj)\left(U_{Tm} + nU_{Dm} + xU_{Cm} + U_{CAB} + \left(\left(\frac{x(y + 2tr)}{2}\right)U_{GTM} + FU_F + \frac{U_{TH}}{Sj} + WU_{CW}\right) + 2(U_{CB}) + z(U_{ys})\right)\right)$$

Where

Bj/c = Bushels/Bushels per ton of grain, moved to destination j; c is the conversion factor bushels to tons

Mj = Average mileage moved to destination j

x = Average number of cars per train

y = Average tons per car

z = Yard switching minutes per car

tr = Average tons weight per car

n = Average number of locomotives per train

Sj = Average train speed to destination j

F = Estimated annual fuel consumed in gallons

W = Estimated annual crew wages

U_{Tm} = Unit cost per train mile

U_{Dm} = Unit cost per diesel mile, (3000 h.p. locomotives assumed for the unit train)

U_{Cm} = Unit cost per car mile

U_{GTM} = Unit cost per gross ton mile

U_{CAB} = Unit cost per caboose mile

U_{CW} = Unit cost per dollar of crew wages

U_F = Unit cost per gallon of fuel

U_{ys} = Unit cost per yard switching minute

U_{TH} = Unit cost per train hour

U_{CB} = Unit cost per originating/terminating car of grain